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FINAL REPORT

INCIDENCE OF PINE WOOD NEMATODE DAUERLARVAE AND PHORETIC MITES ASSOCIATED WITH LONG HORNED BEETLES IN CENTRAL LOUISIANA

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INCIDENCE OF PINE WOOD NEMATODE DAUERLARVAE AND PHORETIC MITES ASSOCIATED WITH LONG HORNED BEETLES IN CENTRAL LOUISIANA

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ABSTRACT

In central Louisiana, Monochamus titillator and M. carolinensis are the principle vectors of dauerlarvae of the pine wood nematode. Although proportionally more M. carolinensis carry the nematode, M. titillator is the more abundant species. Neacanthocinus obsoletus, a common longhorned beetle found in dead pines, seldom carries the pine wood nematode. Twelve species of mites are found to have instars phoretic on these cerambycids. Several of these were observed to be nematophagous.

The pine wood nematode, Bursaphelenchus xylophilus (Steiner and Buhrer) Nickle, is the causative agent of pine wilt disease. Cerambycid beetles, especially those belonging to the genus Monochamus, are the primary vectors of this pathogen nematode. Nematodes gain access to healthy trees through feeding wounds on new shoots made by the beetle and are introduced into dead and dying trees through ovipositional pits made by adult female beetles. The pinewood nematode is endemic in North America, and most native species of pine are resistant to pine wilt disease. However, many exotic pine species are highly susceptible. Pine wilt disease was first discovered in the United States in an ornamental Austrian pine (Dropkin and Foudin 1979). Since its discovery there has been growing concern over the pathogenicity and epidemiology of the nematode. It is now generally agreed that sometime near the turn of the century the nematode was inadvertently exported from the United States to Japan where it decimated the native Japanese forests. The recent discovery of the pine wood nematode in wood chips exported from the United States to Finland and Sweden has further increased concern regarding the global transmission of this pathogen through international trade.

The following study was undertaken to determine what species of cerambycid beetles are the primary vectors of the pine wood nematode in central Louisiana, and to survey the mites associated with these beetles, some of which could be nematophagous.

MATERIALS AND METHODS

Within the Catahoula and Winn Ranger districts of the Kisatchie National Forest two barrier traps baited with ipsdienol and ipsenol (Billings and Cameron 1984) were placed adjacent to areas having trees likely to serve as

hosts for cerambycids (logging debris, southern pine beetle spots, etc.). The traps were installed in the field throughout 1984 but cerambycids were caught only in the months from April through October. In 1985 the traps were placed in the field in April and removed in December because cerambycid activity ceased in November. Three areas within a radius of 3 1/4 miles of one another were sampled in 1984. Three areas were sampled in 1985 within 1 mile of one another. The traps were checked once daily, and any cerambycids found were identified to species and gender, diced into sections, wrapped in a laboratory tissue, and soaked for approximately 12 hours in distilled water. The water was then searched for nematodes.

Eleven loblolly pine trees (Pinus taeda L.) were felled at various times and observed at weekly intervals for signs of oviposition by adult longhorn beetles. The first tree was felled in the spring of 1982 and the others between October 1983 and June 1985. When numerous oviposition pits were present and sawyer activity could be heard, the boles of these trees were cut into billets, transported to a greenhouse and placed in rearing containers. Trap trees remained in the field from 10 days to 2 1/2 months before being transported to the laboratory and were held in rearing from three to eight months, depending upon season. Beetles were collected daily as they emerged, and processed in the same manner as those caught in the barrier traps with the exception that all phoretic mites were removed from them. The mites were cleared in lactophenol, counted, and identified to species. Five deutonymphs each of Trichouropoda hirsuta Hirschmann, Trichouropoda lamellosa Hirschmann, Dendrolaelaps varipunctatus (Hurlbutt), Longoseius cuniculus Chant, and three specimens of Mucroseius monochami Lindquist were isolated in individual well slides and offered pine wood nematodes or other mites as prey. Fresh nematodes were added daily over a 4 to 5 day period.

RESULTS AND DISCUSSION

Seven cerambycid species were recovered from the barrier traps (Table 1). The most abundant species was Monochamus titillator (Fab.) followed by M. carolinensis (Oliv.). Adults of both of these species vector the pine wood nematode, but a significantly higher percentage of M. carolinensis are infected with the nematode ($\chi^2 = 33.05$, $P>0.001$). Five cerambycid species emerged from the field-collected loblolly pine bolts (Table 2). M. titillator and Neacanthocinus obsoletus (Oliv.) were the most common species present, and, as with beetles caught in the barrier traps, adults of M. titillator and M. carolinensis were more commonly infested with dauerlarvae of the pine wood nematode than were those of the other three beetle species. As found by Carling (1984), N. obsoletus does not appear to be an important vector of B. xylophilus, and Xylotrechus sagittatus (Germ.) is not a vector. Thirty-eight percent of the Monochamus spp. caught in barrier traps in central Louisiana were infected with dauerlarvae of the pine wood nematode whereas only 7 percent of emerging Monochamus spp. were infected. This is close to the 9.5 percent infestation rate reported by Carling (1984) in Virginia. Linit et al. (1983) found 94 percent of M. carolinensis emerging from Pinus sylvestris L. to contain pine wood nematode dauerlarvae, and Wingfield and Blanchette (1983) found nematode infestations in up to 95.7 percent of the Monochamus spp. emerging from five species of pine (Pinus niger Arnold, P. banksiana Lamb., P. ponderosa Laws., P. resinosa Ait., and P. strobus L.). In all studies, except the one reported here, the beetles were emerging from material known to contain the pine wood nematode. The species having high incidences of infection in the studies by Linit et al. (1983) and Wingfield and Blanchette

(1983) were mostly Monochamus carolinensis and M. scutellatus (Jay) whereas the predominant infestation levels in Carling's (1984) study and the current study were found in M. titillator. These findings, along with the statistically significantly higher incidence of the nematode in M. carolinensis than in M. titillator, suggest that M. carolinensis may be a more efficient vector. However, the importance of M. titillator can not be discounted since it is by far the more abundant of the two species in central Louisiana. Soper and Olsen (1963) found representatives of seven mite families associated with Monochamus spp. in Maine. In the present study, at least twelve mite species, also representing seven mite families, were found with M. titillator and N. obsoletus (Table 3). However, mites of the families Phytoseiidae and Laelapidae found with cerambycids in Maine were not encountered on cerambycids collected in central Louisiana. The greatest number of phoretic mite species encountered in the present study were found from July to September. The most abundant species, Trichouropoda lamellosa, was most common from February through April and again from July through September or October (Fig. 1A). Histiogaster spp. are usually more common during late fall and winter (Fig. 1B). Longoseius cuniculus is most abundant from July through September (Fig. 1C), and Trichouropoda hirsuta is more or less constantly present throughout the year (Fig. 1D). The ascid mite Mucroseius monochami which has been found numerous enough to completely fill an atrium of some cerambycids (Lindquist 1962), was rarely found in this study, and never in an atrium. As found with many mites associated with bark beetles and other cerambycids, different species of mites tended to be found

on specific areas of the beetle. Trichouropoda hirsuta was usually found in the gular region, whereas T. lamellosa and L. cuniculus were usually found under the elytra.

Interestingly, the mite fauna associated with these cerambycids, with the notable exception of Histiogaster spp., is quite different from that of scolytids which share the same subcortical habitat with early instars of cerambycids. For example, Trichouropoda australis Hirschmann and Dendrolaelaps neodisetus (Hurlbutt), two of the most commonly encountered mites associated with the southern pine beetle, Dendroctonus frontalis Zimmermann, are rarely found on cerambycids (Kinn 1982). Conversely, T. lamellosa and T. hirsuta are seldom found phoretic on bark beetles. Longoseius cuniculus is occasionally associated with bark beetles, but is not nearly as numerous as it is on cerambycids.

In Japan, deutonymphs of Dendrolaelaps unispinatus Ishikawa and D. fukikoae Ishikawa have been stated to feed on pine wood nematode dauerlarvae while they are phoretic on their beetle host (Enda and Tamura 1977, Tamura and Enda 1980), but this needs further confirmation. In the present study deutonymphs of the mites T. lamellosa, T. hirsuta and D. varipunctatus placed in isolation cells were observed to feed on the pine wood nematode, and it was suspected that D. isodentatus also is nematophagous, Since nematodes added to isolation cells containing this mite disappeared. Previous observations have revealed that D. neodisetus and T. australis prey upon nematodes (Kinn 1982, 1984). Longoseius cuniculus was not observed to feed on anything. I suspect Mucroseius monochami may prey upon digamasellid mites. Although feeding was not observed, digamasellids placed in isolation cells with M. monochami were found dead the next morning. The cheyletid,

Eutogenes vicinus Summers and Price, is also likely to be a predator of small insects (Eickwort 1983) or other mites, and larvae of Neotrombidium tricuspidum Borland are reported to be parasites of their cerambycid hosts (Borland 1967). The acarids, Histiogaster spp., and the histiostomatid most likely feed on microorganisms (Woodring 1963). Acarids, which have normal chelate chelicerae are probably saprophages or fungivores whereas histiostomatids utilize microorganisms they filter from fluid surfaces.

The results of the piot study reported here, as well as earlier preliminary observations, indicate the need for further research to determine the role played by these mites in the cerambycid - pine wood nematode relationship, and especially to elucidate whether mites actually prey on nematodes or other mites while phoretic on the beetles.

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Table 1. Species of cerambycid beetles recovered from barrier traps and percent of beetles carrying dauerlarvae of the pine wood nematode.

Species	Number Examined	Percent Infected
Monochamus titillator (Fab.)	674	31.4
Monochamus carolinensis (Oliv.)	343	50.0
Neacanthocinus obsoletus (Oliv.)	299	3.0
Tylocerina modosus (Fab.)	9	0
Xylotrechus sagittatus (Germ.)	5	0
Stenocorus inquisitor lineatus (Oliv.)	5	0
Asemum striatum (L.)	2	0

Table 2. Species of cerambycid beetles emerging from field collected loblolly pine bolts and percent of the beetles carrying dauerlarvae of the pine wood nematode.

Species	Number Examined	Percent Infected
Monochamus titillator (Fab.)	277	6.5
Monochamus carolinensis (Oliv.)	17	17.6
Neacanthocinus obsoletus (Oliv.)	203	1.5
Xylotrechus sagittatus (Germ.)	134	0
Tylocerina modosus (Fab.)	8	0

Table 3. Phoretic mites commonly found on *Monochamus titillator* and *Neacanthocinus obsoletus* beetles emerging from loblolly pine bolts.

Species of Mites	*M. titillator* (n=157)	*N. obsoletus* (n=95)	Total (n=252)
Parasitiformes			
Gamasida			
Digamasellidae			
Dendrolaelaps varipuctatus (Hurlbutt)	646	325	971
Dendrolaelaps isodentatus (Hurlbutt)	614	0	614
Dendrolaelaps neodisetus (Hurlbutt)	38	12	50
Longoseius cuniculus Chant	4332	363	4695
Ascidae			
Mucroseius monochami Lindquist	40	0	40
Uropodidae			
Trichouropoda lamellosa Hirschmann	8578	730	9308
Trichouropoda hirsuta Hirschmann	2461	117	2578
Trichouropoda australis Hirschmann	1	0	1
Acariformes			
Actinedida			
Cheyletidae			
Eutogenes vicinus Summers and Price	0	1	1
Neotrombididae			
Neotrombidium tricuspidum Borland	0	2	2
Acarida			
Acaridae			
Histiogaster spp. (mostly *arborsignis* Woodring)	2535	2512	5047
Histiostamatidae			
Histiostoma varia Woodring and Moser	3	0	3

FIGURE LEGENDS

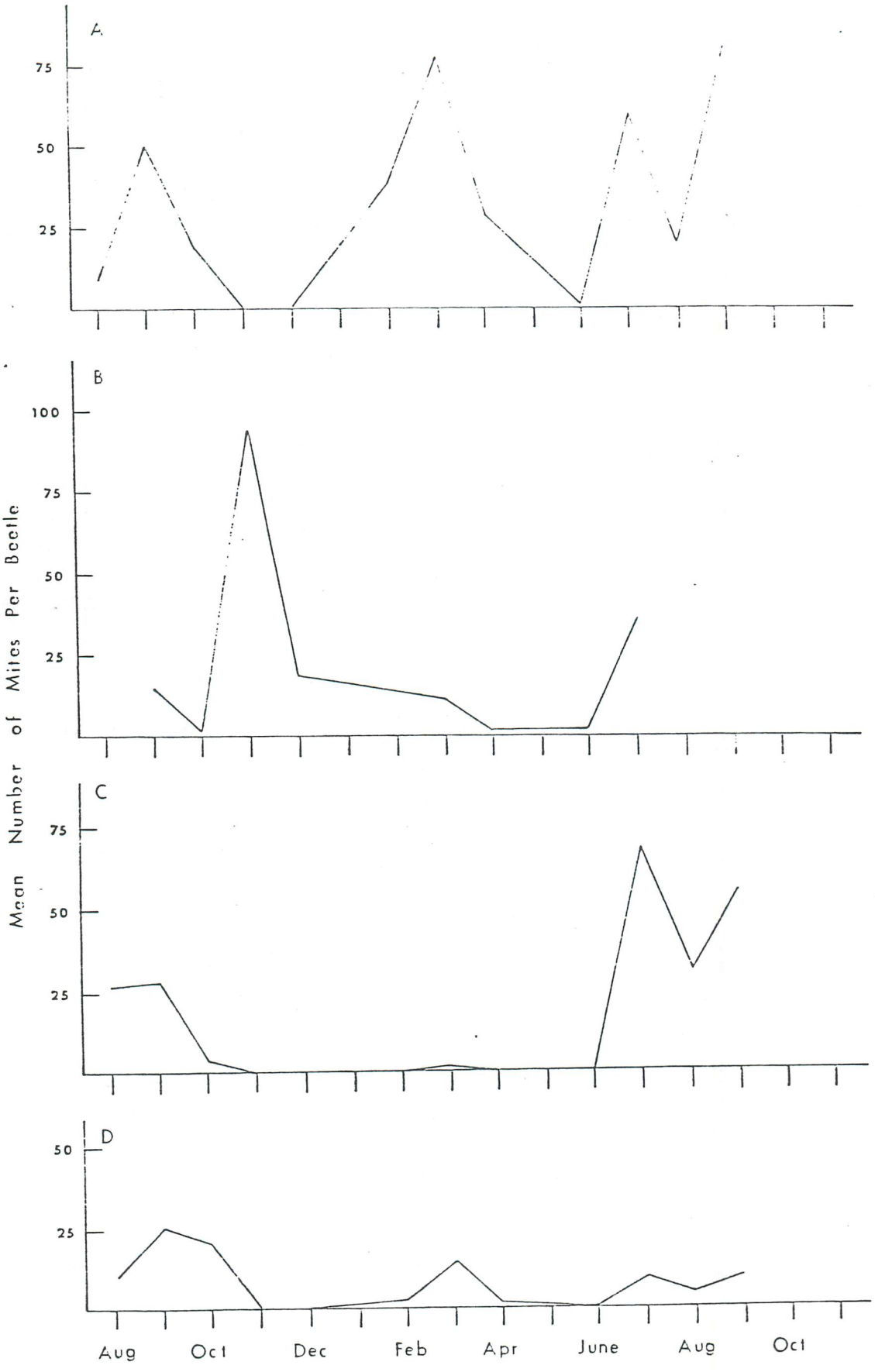
Fig. 1. Mean number of mites per beetle by month (1984-1985).

A. *Trichouropoda lamellosa*

B. *Histiogaster* spp.

C. *Longoseius cuniculus*

D. *Trichouropoda hirsuta*


A
75
50
25
B
100
75
50
25
C
75
50
25
D
50
25
Mean Number of Miles Per Beetle
Aug
Oct
Dec
Feb
Apr
June
Aug
Oct